D R A F T

Casement Window Restoration

November 14-29, 2011

City of Evanston

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Casement Window Restoration Study

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INTRODUCTION

In historic buildings window restoration is not always first considered. Homeowners are frequently convinced that "modern" windows are an improvement in overall performance. This is a result of marketing and sales of new window products. A properly maintained and weatherstripped historic wooden window with a storm window will easily eclipse new windows in energy efficiency and function after two or more years.

To improve function, historic windows can be stripped of all paint, glazing compound and glazing. Once properly repaired, when loose muntins and the rails and stiles have been secured, it can be reglazed and the wood painted with a final top coat. Especially important to the restoration is also the cleaning and repair of the window hardware, which contributes to the overall function and appearance of the restored window.

Not included in the enclosed restoration are the components of the double hung sash, the vertically sliding window which was and still remains the most popular and most ubiquitous of window types in residential construction. Double hung sash and single hung sash windows are especially prevalent in Evanston. These windows have many more parts and a pulley system keeping them from slamming shut after they have been opened.

The following report reviews the techniques which would ideally be used in a typical restoration. Given the limitations of time and the actual shop use of other materials is not described within this report: the process of restoration described here was modified in order to conform to known standards specified by field specialists (see **"Notes"** #1 - #12 on **page 19** for more information). The described methods in the text and illustrations of this report are used for major restoration projects in national landmark buildings and historic districts, according to the needs of each project. Pay close attention to the text and illustrations as they mention steps which would improve the quality of the restoration shown in the case study photographs.

Window History

Three major types of historic windows are fixed, casement, and sliding sash. Early uses of casement windows in medieval Europe were in large estates, churches or public buildings. Window glass during the medieval period was expensive, and most windows in the average home were simply a hole in the wall. Wrought iron windows were not uncommon, it was used to make both fixed and casement windows. In the confines of recent architectural history, the wooden sash is a relatively modern development. Early examples of the wooden single hung sash date to the late 17th century and was used in finer homes. A prop was sometimes used to keep the bottom sash open while the top sash remained fixed. In England sash weights, pulleys and double hung sashes were being used in the early 18th century.[a] Development of counterweighted wooden sash was seen alongside rare examples of metal (copper, cast iron, steel) sliding sash counterparts in the 18th and 19th centuries.[b]

In relation to the American colonies, the casement window sash was the earliest used. The availability of window glass was a challenge to early settlers. Glass was imported to British colonies from "glass houses" and furnaces across the Atlantic.

The "wavy" texture of historic glass comes from the types of tools and techniques used to create the glass. Crown glass was a type of blown glass where the glass was blown into a large bubble and then flattened into a disc. During the 18th and 19th century, the glass crown or disc was placed on a stepped wall in the glass manufactory which served as a rest for the blowpipe and pontil rod while the glass was twirled or "flashed" to expand it into a disc or crown with the aid of the heat from the furnace and centrifugal force. This does not impart the glass with a perfectly made or completely flat surface. The full crown or table was then cut to standard sizes; occasionally the entire table was sent to the builder who would then have glaziers cut it at their location.

In the nineteenth century glass cylinders were blown and formed by a swinging technique which created sizes up to 16 or 18 inches in diameter and 7 feet in length. After swinging out the cylinders (using centrifugal force) to their final length in special pits, they would, while hot, be split down their length and placed in flattening ovens. The tables of these flattening ovens consisted of a smooth plaster of Paris. Despite efforts to create a perfectly smooth surface, imperfections persisted.[c]

A Timeline of Window History, 1500BC – 1900AD

1500-1401BC (15th century BC) Core-formed and cast glass vessels were produced in Egypt and Mesopotamia.

0-100 AD (1st Century AD or the Roman Early Imperial Period) Cast and blown window glass was used; the most prominent use was in Roman public baths. Cast panes were poured and rolled over flat, usually wooden molds laden with a layer of sand, and then ground or polished on one side.

0-100AD (1st century AD or the Roman Early Imperial Period) Glass blowing was developed; the cylinder glass method was used to make window glazing. In Roman buildings window glass was used to prevent drafts and used for security reasons; Roman window glazing was not perfectly transparent or even, it was not used to provide light or a view of the outside.[d]

900 - 1500AD (10th century AD - 16th century AD) Window glass during the European medieval period was restricted to use in public buildings, churches (such as stained glass windows), and in large estates. Glass molds, the cylinder glass method and the crown glass method were used to make this window glazing.[e]

1500-1600 (16th century AD) Window glass became more affordable and consequently more common in the average home in England during the reign of Elizabeth I. Casement windows with diamond "quarrels" or small diamond panes in held with wire and leaded came strips predominated this period and into the 17th century.[f]

1620 Window glass was first imported across the Atlantic to America. Domestic attempts at manufacturing domestic window glass in the English colonies in America did not reach any significant scale until the late 18th century. In Europe and in the colonies the predominant methods of manufacturing were the traditional cylinder glass and crown glass methods. Cylinder glass had many imperfections (such as bubbles) and was inferior in quality to crown glass.

1600's The earliest window type in the colonies was casement windows. Archaeological excavation unearthed at least one metal casement window in the Jamestown settlement in Virginia (1607-1699). However most homes could not afford glazed windows and simply had an opening in the wall.

1700-1750 Sliding sash windows began to be used in the colonies.

1792 Boston Crown Glass Manufacturing was established and later supplied the window glass for construction at the U.S. Capitol building from 1815-1824. Housing design incorporated the increasing availability and larger size of window glass.

1795 & 1807 For his architectural accomplishments, Thomas Jefferson ordered a total of 750 panes of Bohemian or Hamburg glass from a supplier in Philadelphia. Both the Revolution and the War of 1812 had an impact on the import of English glass, increasing speculation and manufacture of domestic glass.

1800-1900 Glass manufacturing developed to meet a small portion of the United States' market demand while imports still dominated.
1853/1854-1872 Lenox Glass Works in the Berkshires of Massachusetts made plate glass during this period. Plate glass panes during this period were expensive; a pane 16 feet 6 inches high and 7 feet wide could easily cost $3000.
1903 The cylinder glass method was perfected by J.H. Lubbers, using the "Lubbers Method". This produced cylinders 40 feet long and 30 inches in diameter.[7]

Notes

a. English Heritage, “Timber Sash Windows" *Framing Opinions Leaflet 4* (1997), accessed January 2, 2012, http://www.english-heritage.org.uk/publications/timber-sash-windows/
b. Peter Clement, "History of Metal Windows" *Period Property UK* (October, 2008), accessed January 2, 2011, http://directory.periodproperty.co.uk/article/history_of_metal_windows.html
c. Kenneth M. Wilson,“Window Glass in America” in *Window Rehabilitation Guide for Historic Buildings*, ed. Charles E. Fisher III, et al., (Washington, D.C.: Historic Preservation Education Foundation, 1997).
d. Rosemarie Trentinella, "Roman Glass" *The Metropolitan Museum of Art: Heilbrunn Timeline of Art History*, accessed January 2, 2012, http://www.metmuseum.org/toah/hd/rgls/hd_rgls.htm
e. "Medieval Stained Glass" *Wikipedia*, accessed January 2, 2012, http://en.wikipedia.org/wiki/Medieval_stained_glass
f. Linda Hall "Early Casement Window Furniture", in *The Building Conservation Directory*, (Wiltshire, UK: Cathedral Communications Ltd., 2001), accessed January 2, 2012, http://www.buildingconservation.com/articles/windowfurn/windowfurniture.htm
g. Kenneth M. Wilson,“Window Glass in America” in *Window Rehabilitation Guide for Historic Buildings*, ed. Charles E. Fisher III, et al., (Washington, D.C.: Historic Preservation Education Foundation, 1997).

1.) 2nd floor casement window prior to removal.

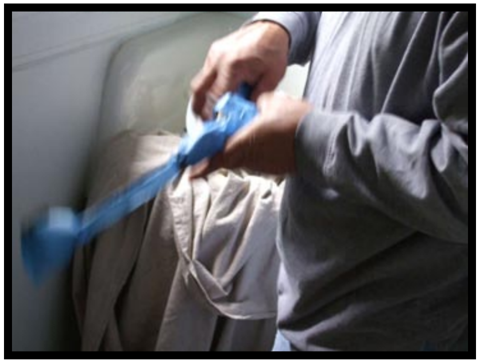
2.) Indoor screen for a casement window

3.) 2nd floor casement sash operator

4.) 3rd floor casement window sash operator

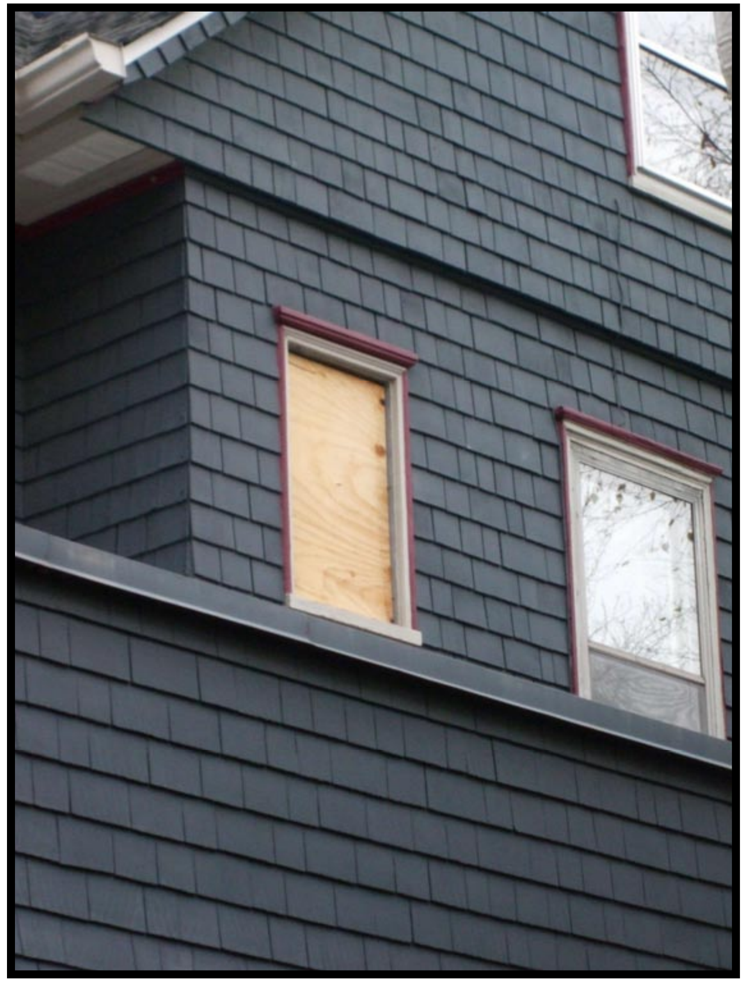
5.) Casement latch.

Carefully remove the window and any connecting hardware. If exterior storm windows are to be installed make certain to take dimensions at this time.



6.) The casement hardware is wrapped with painter's tape and labeled.

7.) Plywood is installed temporarily with drywall screws driven into the jamb. Painters tape was applied to prevent air infiltration.



8.) 2^{nd} floor window from the exterior after removal of the window sash.

Please consult state, local and federal guidelines when dealing with lead paint.

Four casement windows were restored in this project. For larger jobs where more windows will be removed, use a vacuum equipped with a HEPA* filter during clean-up.

Protect the workspace with a drop cloth. Remove any and all lead paint, lead dust, or lead chips which result from removal and reinstallation of a window.[1]

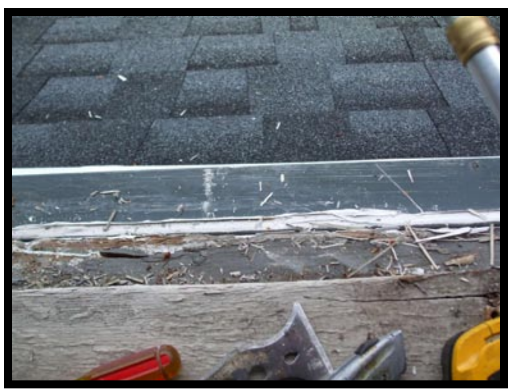
***H.E.P.A.** - (High-Efficiency Particulate Air) To qualify as HEPA by government standards, an air filter must remove 99.97% of all particles greater than 0.3 micrometer from the air that passes through.*

9.) 3rd floor casement windows.

10.) 3rd floor bathroom casement window

11.)Vacuum used for cleanup.

12.) Tools for this phase.



13.) Rot at 3rd floor sill. A partial earlier repair by another contractor was discovered.

14.) Plywood panels installed following removal.

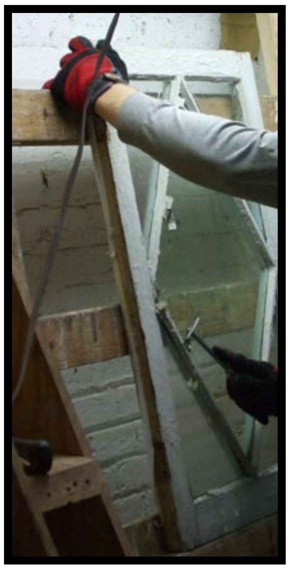
15.) Remaining hardware removed at the shop.

"Tools for this phase" (photograph #12) included a cordless drill, a vacuum with a filter, a circular saw, saw horses, a screw-driver, a putty knife, a hammer, a small pry bar, an utility knife, and a 5-in-1 painter's tool.

16.) Window placed in a steam box.

17.) Window removed from the steam box.

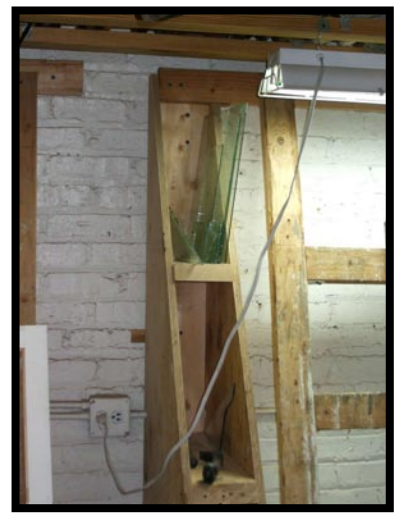
18.) 2nd floor bathroom window on the sash easel.



19.) Paint and putty scraping, removal.

Steam removal of lead paint is gaining in popularity due to the following advantages over other methods:
1.) It eliminates the risk of fire due to the paint removal process.
2.) It minimizes lead-dust health risk because it is a damp process.
3.) Steam removal does not cause the fumes of other heat removal techniques.
4) For most projects the cost of steam paint and glazing removal is relatively low.
5.) Operating and supply costs are much lower than chemical paint strippers.
6.) Disposal costs are relatively low.[2]

20.) Glass panes removed.



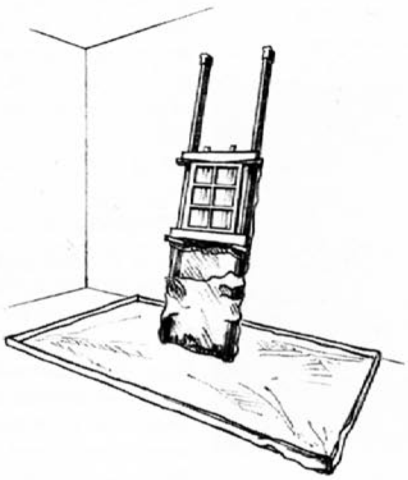
21.) Temporary storage for the panes.

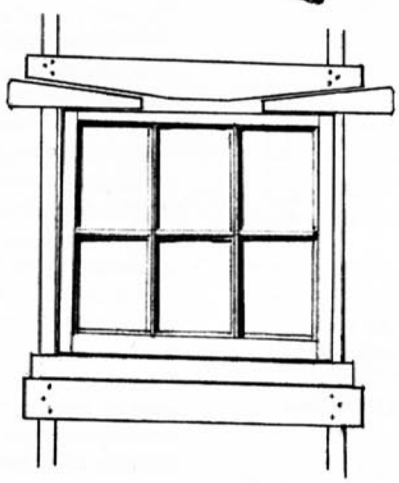
Sash Easel

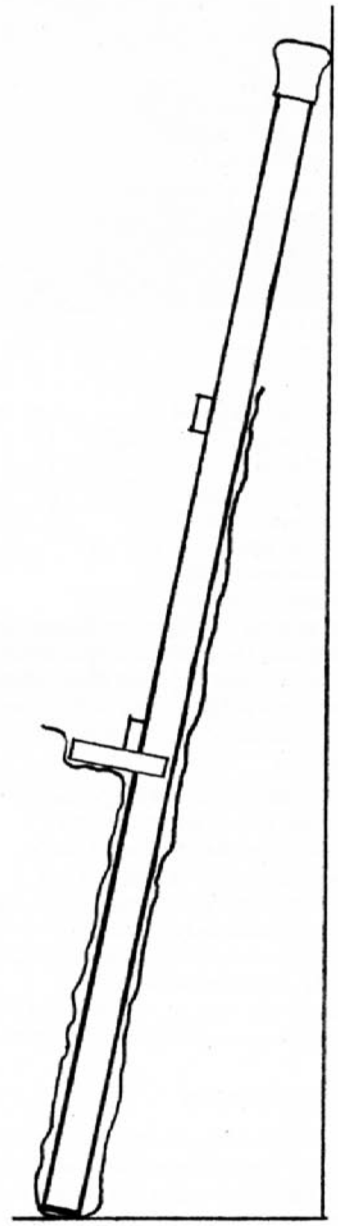
The window sash easel holds sashes at a convenient height to reduce fatigue and back pain during long production work sessions. A skilled carpenter can easily construct one in 30 minutes from three 2x4s, 8 feet of 1x2 wood furring strip, 1 dozen 3", and one dozen 1 1/2" wallboard-style screws. Adjust the height of the two rails so the middle of the sash is at the worker's elbow. The top rail is tapered on the same angle as the wedges. Set the separation of the rails to accommodate the width and height of the sash. The sash is clamped down and held steady by the two wedges above, and can be easily repositioned, rotated and flipped by loosening and re-driving the wedges. A spacer block resting on the lower rail makes up the difference between the width and height of the sash in different positions.

A supply of 6-mil poly-sheeting and duct tape is needed to form the debris containment that wraps down the front of the easel and up the backside to the top of the sash. Tape up the side edges of the poly to form a bag around the lower section of the easel. Lead containing debris from deglazing and paint removal falls into the poly containment. A HEPA vacuum can be attached to the containment to draw fine dust particles into the containment. When the containment is about half full it can be slid off the easel and disposed of without spreading the dusty debris all around the work area.

The easel can be taken apart and screwed into a narrow pack for hauling and storage. When a project is complete, an easel can be left at the site for ongoing sash maintenance, repair and painting.







This sash easel is a good demonstration of how to set up for lead paint removal and to make repairs on wooden sash.[3]

22.) Sash placed back in the steam box.

23.) [Day 2] Much of the paint has been removed.

24.) Scraper attachments for paint removal.

Having a variety of scrapers on hand to remove paint is quite useful. These conform to different mouldings and irregular surfaces found on rails, stiles, and muntins.

25.) 3rd floor casement after steaming and scraping.

26.) Scraping paint from the window muntins.

27.) Paint remover applied to aid in scraping paint from the window muntins.

In photograph #27 a small amount of paint remover is used to remove paint residue from areas which are hard to reach. When using a chemical stripper it is important to clean off the remaining chemical residue from the wood surface with a manufacturer recommended cleaning solvent. Which solvent to use depends upon the composition of the paint remover, especially since some chemical strippers are water based.

Cleaning off the paint remover paste and any wax that may be combined with them to form the paste is necessary as they can prevent paint adhesion.[4]

28.) Orbital sanding with HEPA vacuum attached.

29.) Rot, deterioration on 3rd floor casement stile.

30.) Parts A and B epoxy.

31.) Mixing equal parts of the wood epoxy.

Photograph #29 shows signs of rot. Removal of severe rot should be considered first.[5] However where decay removal is not planned or practicable, the application of wood preservatives should be implemented. Drill holes to help the preservatives penetrate deep into the wood. After applying wood preservatives, use a consolidant to harden the wood and provide a stable, clean base for adhesion to epoxy filler repairs.[6] For more information on this process, please view the resources listed at the end of this presentation.

Minor Decay Within Joint

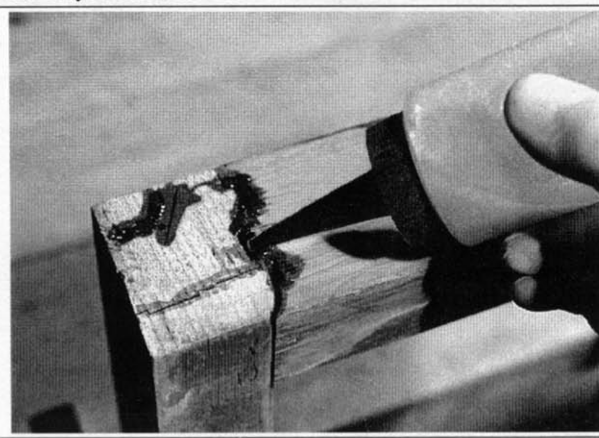
This treatment is for joints that are just a little loose and have limited decay within the joint. This method locks the joint.

Step 1. Clean & Prep. Scrape loose paint away from the joint. Clean old paint and putty out of the joint with a crack tool.

Step 2. Inject Borate Preservative. See Stabilize Loose and Decayed Joints for this treatment.

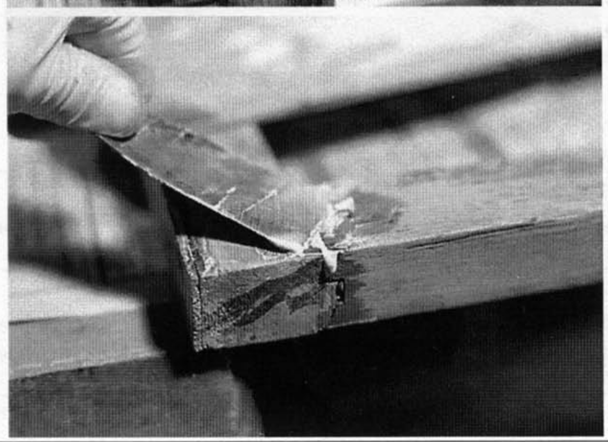
Step 3. Soak in Epoxy Consolidant.

Apply the consolidant with a narrow spouted bottle just along the crack of the joint opening. Do not spread consolidant all over the outer surfaces of the style and rail. This would leave an outer casing of epoxy that would trap moisture-causing decay. Do apply epoxy to all of the end-grain exposed on the end of the stile and on the end of the tenon. Move on to apply consolidant to other joints and then return to apply more as it soaks in. The goal is to cover all the interior surfaces of the joint and saturate any decayed wood within the joint.



Step 4. Fill Gaps with Epoxy Filler.

On a flat board, mix a little epoxy consolidant with some of the epoxy paste filler to thin the filler's consistency. Work the thinned paste into the joint from all three sides with a putty knife. Then work in some of the thicker paste. This forces the thinner mix deep into joint. The goal is to completely fill the joint with paste.



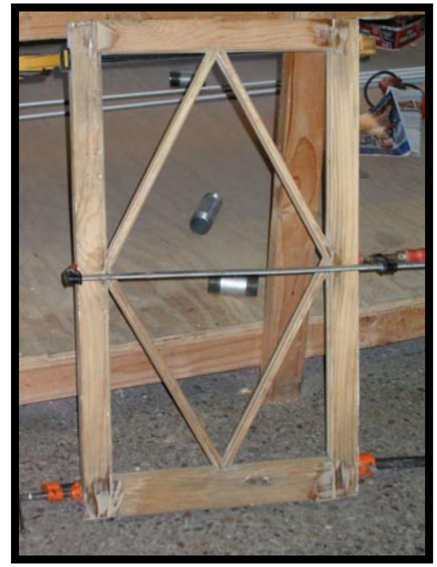
Step 5. Clamp Up. If necessary, close the joints with bar clamps. Only a light pressure is needed. Over-tightening can break the sash. Be sure the sash is flat and square. Let the epoxy cure overnight

Step 6. Trim & Sand. Trim cured epoxy from glazing rabbet and sand or scrape film of epoxy from all surfaces to expose bare wood.

The described process above is recommended for the sash joint repairs shown on the following pages.[7]

32.) Applying epoxy filler to the 2nd floor casement sash stile end grain.

33.) Clamps placed around the frame while epoxy dries.



34.) Three clamps were used prior to drying in the "heat room".

35.) 2nd floor casement sash left to dry in the "heat room".

36.) The "heat room".

Moderate heat was used to accelerate the drying process. Within a shop environment, low Fall temperatures can be avoided and materials allowed to dry more efficiently within higher recommended ranges. Note that high heat above seasonal outdoor temperatures can cause glues, epoxies, glazing compound, paint and other window components to fail.

37.) A HEPA vacuum is attached to an orbital sander.

39.) Loose muntin repair: an adhesive is applied, and the joint is clamped with tape.

38.) [Day 3] Orbital sanding of the epoxy.

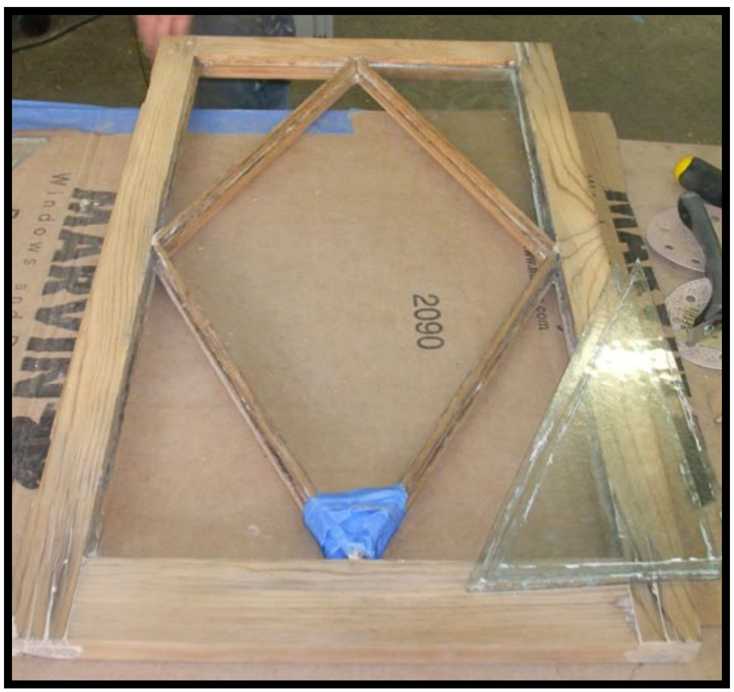
When repairing loose joints as in photograph #39, consider what caused the joint to fail. If rot is the cause and the rot cannot be completely removed or replaced, then wood preservatives should be applied, followed by consolidants and epoxies designed for this purpose.

Exterior wood adhesives can otherwise be used as shown in photograph #39.

42.) Glass panes test fitted.

In fitting new glazing (glass panes) to the window, be sure to allow 1/16" gap on all sides from the rails, stiles, and muntins, or subtract 1/8" from the height and the width. This will speed installation as the edges for the glazing do not have to be absolutely precise. Cutting glass, however, can require much patience and skill.[8]

When reusing historic glazing, clean the surface of the glass thoroughly prior to reinstallation.



43.) 2nd floor casement prior to re-glazing.

44.) Glass cleaned with window cleaner and a straight razor.

47.) The glazing compound is kneaded, rolled up and placed over the glass and glazing points.

In photograph #46 a bed of glazing compound was applied and the glass is pressed into the rabbet. Before installation of the glass it is frequently recommended that the bare wood should be brushed with boiled linseed oil and painted with an oil based primer to prevent the wood from absorbing excess moisture from the glazing compound, allowing the compound to dry slowly and promote better adhesion to the window sash through long term exposure to the weather.[9,10]

Always install glazing points when installing window glass.

48.) Glazing compound pressed into muntins, rail, stiles with a putty knife.

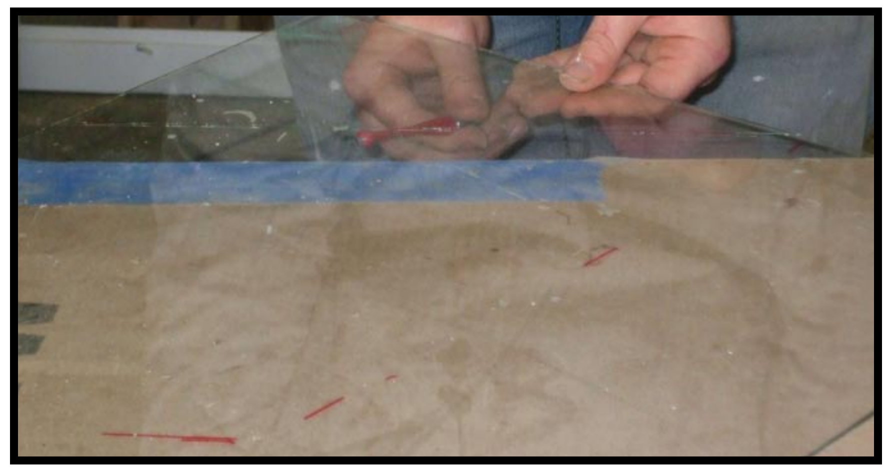
46.) Glass pane installed over glazing compound bead; glazing points installed.

49.) Glazing putty cut to profile with a putty knife.

50.) Opposite face of glass cleaned of excess latex glazing compound.

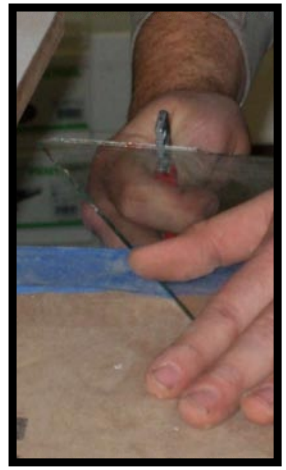
As shown in photograph #49, the glazing putty should visually match the profile of the wood on the opposing side of the glass.For most people, this takes some practice and skill.

51.) Cracked center pane for the casement dimensioned for replacement.



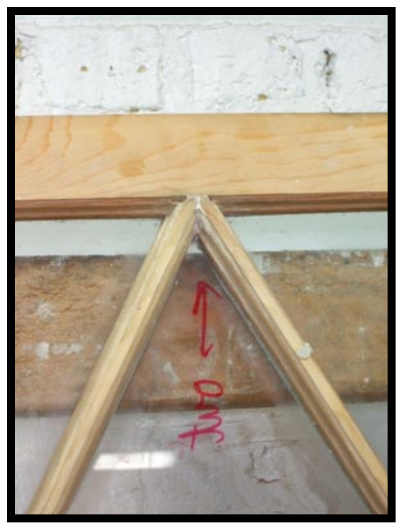
52.) Cutting a new center pane.

53.) Center pane is trimmed to fit 2nd floor casement muntins.



54.) Trimming center pane.

55.) [Day 4] Glazing completed. Profile of glazing putty.



56.) Previous adhesive repair after curing overnight.

57.) Complete window prior to painting.

58.) Casement operator hardware and sash hardware undergoing cleaning and lubrication.

59.) Paint is loosened from hardware with TSP and hot water.

60.) Remaining paint is removed from window latch with a wire wheel.

61.) Window latches prior to final paint removal with a wire wheel and after using the wire wheel on the bench grinder.

Paint removal methods for hardware vary. Soaking overnight in a container of hot water and granulated dish detergent or TSP are two examples. A stiff brush and a pair of gloves is often all that is needed to clean most hardware.[11]

Final painting for this casement window was an initial coat of white primer followed by two finish coats. Latex based paints were used. Spring bronze and other varieties of weather-stripping are typical for this type of installation.[12]

Photographs 62,64,65 were provided by the building owner.

Photograph 63 by Tim Murphy, TMC Windows, Skokie, Illinois.

62.) A Wood's Vacuum Cup is being used to install the restored sash. An interior storm window is on the right in this photograph.

63.) The restored casement window is installed.

64.) The interior storm window is installed. Tabs at each corner hold the storm window in place. The casement operator crank has been removed and stored for the winter.

65.) The restored casement window as seen from the building exterior.

NOTES

1. Dennis Livingston, et al., *Lead Paint and Historic Buildings: Training Manual.* (Springfield, Illinois: Illinois Historic Preservation Agency, 2000), http://www.illinoishistory.gov/PS/leadpaint.htm , 108.
2. John Leeke, *Steam Paint Removal*. (Portland, Maine: John Leeke's Historic HomeWorks, 2006), 4.
3. John Leeke, *Saving Your Wood Windows*. (Portland, Maine: John Leeke's Historic HomeWorks, 2009), 39.
4. Meany, Working Windows, 83.
5. John H. Myers, "The Repair of Historic Wooden Windows," *Preservation Briefs 9* (Washington, DC: Technical Preservation Services, National Park Service, U.S. Department of the Interior, 1981). http://www.nps.gov/hps/tps/briefs/brief09.htm , Repair Class II: Stabilization.
6. John Leeke, *Wood-Epoxy Repairs for Exterior Woodwork.* (Portland, Maine: John Leeke's Historic HomeWorks, 2009), p.1-30.
7. John Leeke, *Saving Your Wood Windows*. (Portland, Maine: John Leeke's Historic HomeWorks, 2009), 47
8. Terry Meany, *Working Windows, 3rd ed.: A Guide to the Repair and Restoration of Wood Windows*. (Guilford, Connecticut: The Lyons Press, 2008), 94.
9. Ibid, 96.
10. John H. Myers, "The Repair of Historic Wooden Windows," Preservation Briefs 9 (Washington, DC: Technical Preservation Services, National Park Service, U.S. Department of the Interior, 1981), http://www.nps.gov/hps/tps/briefs/brief09.htm , Repair Class I: Routine Maintenance.
11. Terry Meany, *Working Windows, 3rd ed.: A Guide to the Repair and Restoration of Wood Windows*. Guilford, Connecticut: The Lyons Press, 2008, 126.
12. Brad James, et al., *Testing the Energy Performance of Wood Windows in Cold Climates.* (Burlington, Vermont: The State of Vermont Division for Historic Preservation, Agency of Commerce and Community Development, 1996), http://ncptt.nps.gov/testing-the-energy-performance-of-wood-windows-in-cold-climates-a-report-to-the-state-of-vermont-division-for-historic-preservation-agency-of-commerce-and-community-development-1996-08/ , 33-34.

FURTHER READING

Charles E. Fisher III, *The Window Handbook: Successful Strategies for Rehabilitating Windows in Historic Buildings.* Washington, D.C.: Historic Preservation Education Foundation, 2008.

Charles E. Fisher III, et al., *Window Rehabilitation Guide for Historic Buildings.* Washington, D.C.: Historic Preservation Education Foundation, 1997.

World Wide Web Resources:

National Fenestration Rating Council data on modern window efficiency
http://cpd.nfrc.org/cpd2/

John Leeke's Historic Homeworks
http://www.historichomeworks.com/hhw/index.htm

National Institute of Building Sciences, Whole Building Design Guide
http://www.wbdg.org/resources/sustainable_hp.php

The Secretary of the Interior's Standards for Rehabilitation
http://www.nps.gov/tps/standards/rehabilitation/rehab/stand.htm
http://www.wbdg.org/pdfs/secint_stndrehabsustainhb.pdf

Windows Through Time (exhibit), Historic Preservation Education Foundation
http://hpef.us/historic-windows/windows-through-time

Saving Wood Windows, State of New Jersey
Department of Environmental Protection
Natural & Historic Resources Historic Preservation Office
http://www.state.nj.us/dep/hpo/4sustain/windowsave_b.pdf

World Wide Web Resources (continued):

Window Restoration Workshop, (San Antonio Office of Historic Preservation, May 2009)
http://www.sanantonio.gov/historic/Docs/Brochures/WindowRestorationWorkshop.pdf

Association for Preservation Technology, *What Replacement Windows Can't Replace: The Real Cost of Removing Historic Windows*
http://www.state.il.us/hpa/ps/images/replacement_windows.pdf

National Trust for Historic Preservation, "Historic Wood Windows"
http://www.preservationnation.org/about-us/regional-offices/what-is-preservation/additional-resources/2009-Revised-Window-Tip-Sheet.pdf

Susan Swiatosz, "A Technical History of Late Nineteenth Century Windows in the United States." *Bulletin of the Association for Preservation Technology - APT*, Vol. 17, No. 1 (1985), 31-37, http://www.jstor.org/stable/1494065

National Park Service Preservation Briefs
Brief #3: Conserving Energy in Historic Buildings (under revision as of 10/2011)
http://www.nps.gov/history/hps/tps/briefs/brief03.htm
http://www.oldhouseweb.com/how-to-advice/preservation-brief-conserving-energy-in-historic-buildings.shtml
Brief #10: Exterior Paint Problems on Historic Woodwork
http://www.nps.gov/history/hps/tps/briefs/brief10.htm

Top Ten Reasons to Restore or Repair Wood Windows, New England Window Restoration Alliance:
http://www.windowrestorationne.org/topten.pdf

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